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GB 1310192 A
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JP 110198608 A
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(54) Abstract Title: **Asymmetrical tyre tread pattern**

(57) To enhance dry grip performance, hydroplaning resistance, and wear resistance, a tyre inner tread half Si is provided with a straight circumferential main groove 10 in a region spaced from a tire equator C by a distance 20 to 55% of a tread half width TW/2. An outer tread half So is not provided with a circumferential groove, but with one or more outwardly inclined lateral main groove(s) 20 each having a lateral groove main portion 21 which extends from the tire equator C toward a tread end Eo at an inclination angle β of 35° or greater, with an inner portion 22i in communication with the main groove 10 and/or an outer portion 22o in communication with a tread end E. The inner half Si has lateral grooves 11 communicating with the main groove 10 or tread end Ei. The main groove 10 has inclined walls. The groove ratio for the tread is 0.15 to 0.35, that for the inner half being slightly greater than for the outer half (0.05 or more).

FIG.2

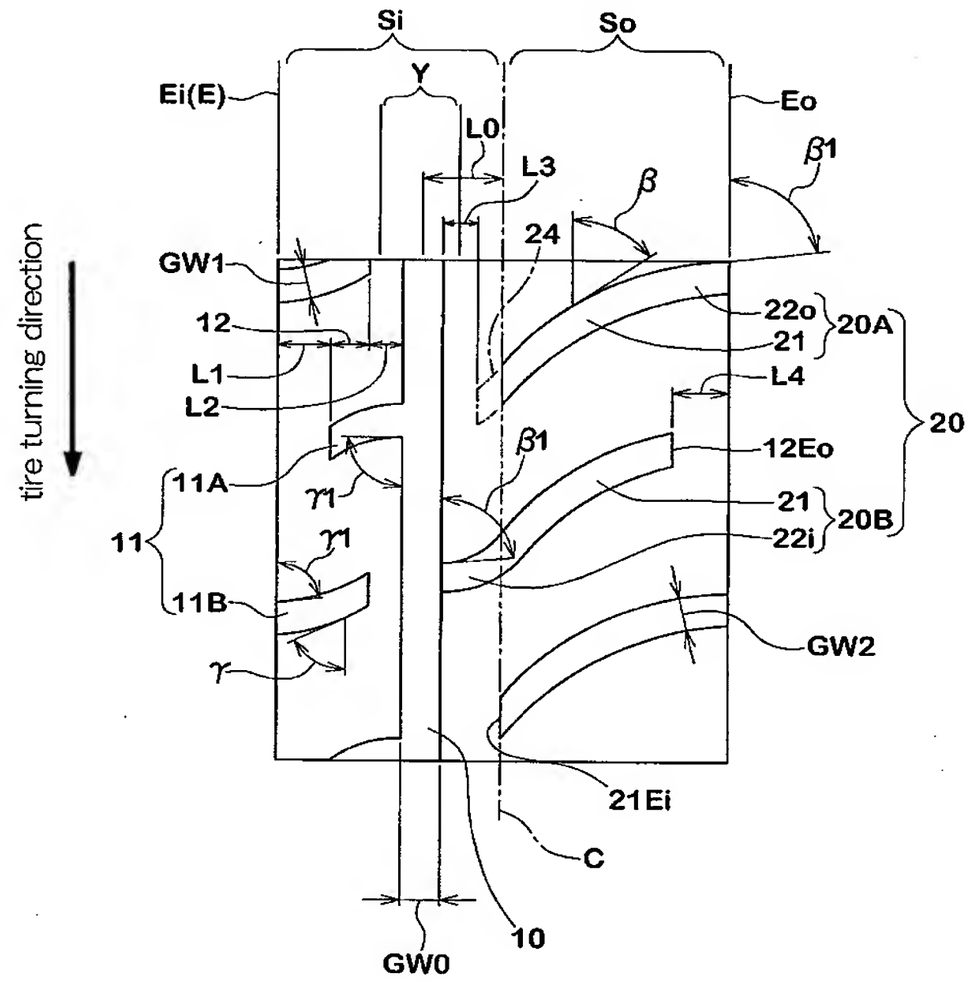

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FIG.1

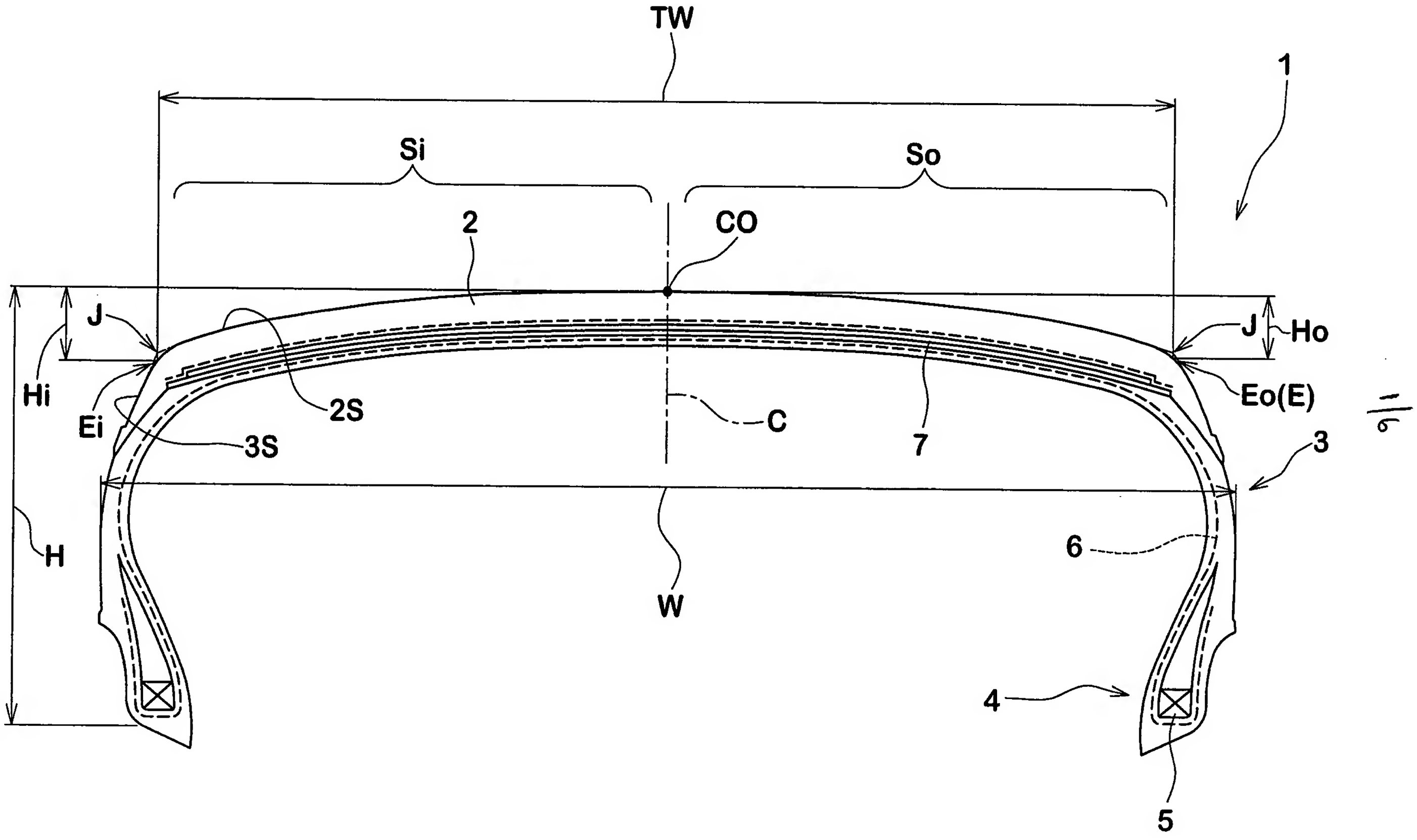


FIG.2

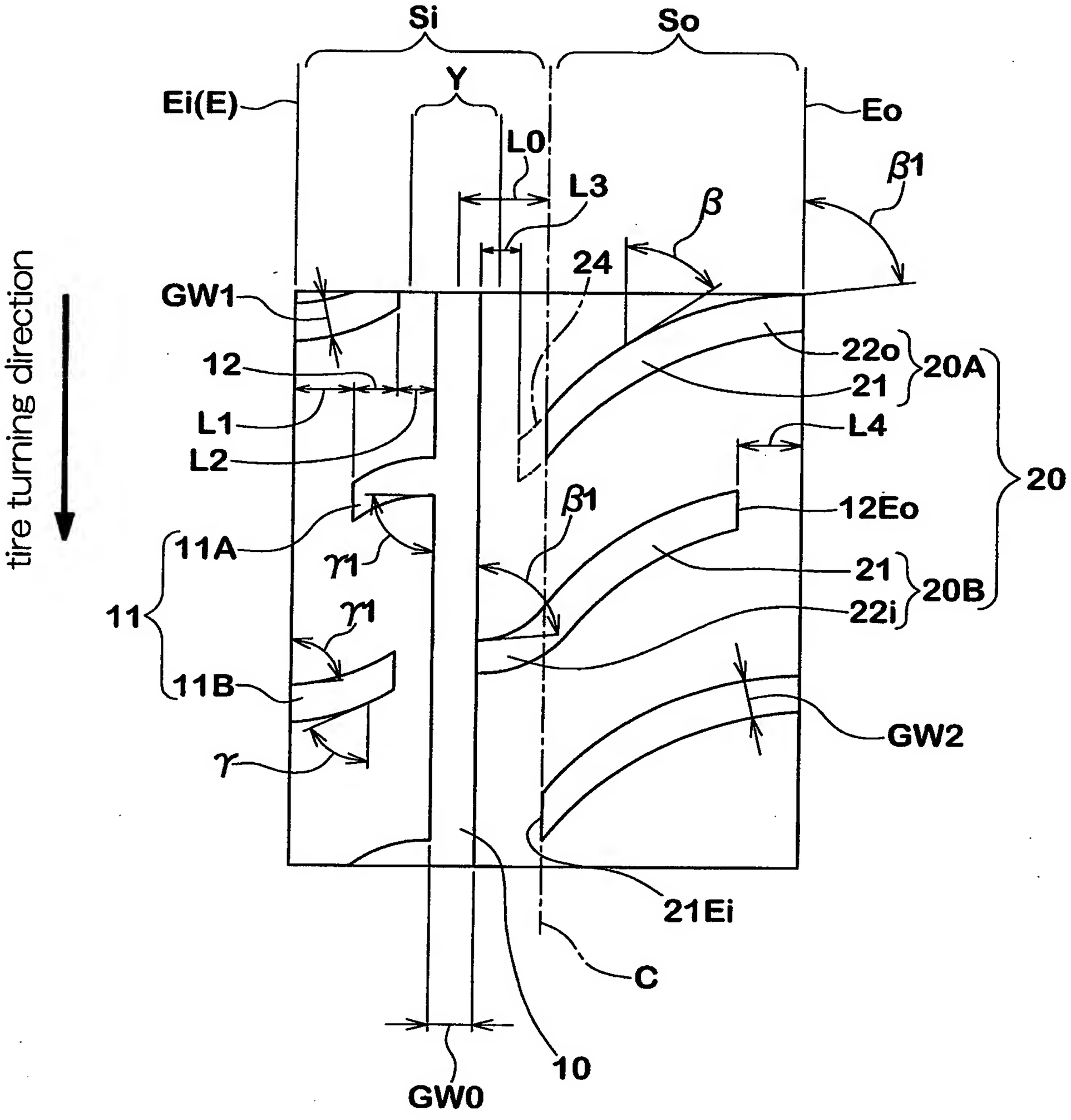

Si
So
Y
Ei(E)
Eo
L0
L3
β1
β
24
GW1
22o
20A
12
21
L1
L4
L2
20
β1
12Eo
11A
γ1
21
20B
γ1
11
22i
γ1
11B
GW2
γ
21Ei
C
10
GW0
tire turning direction

FIG.3

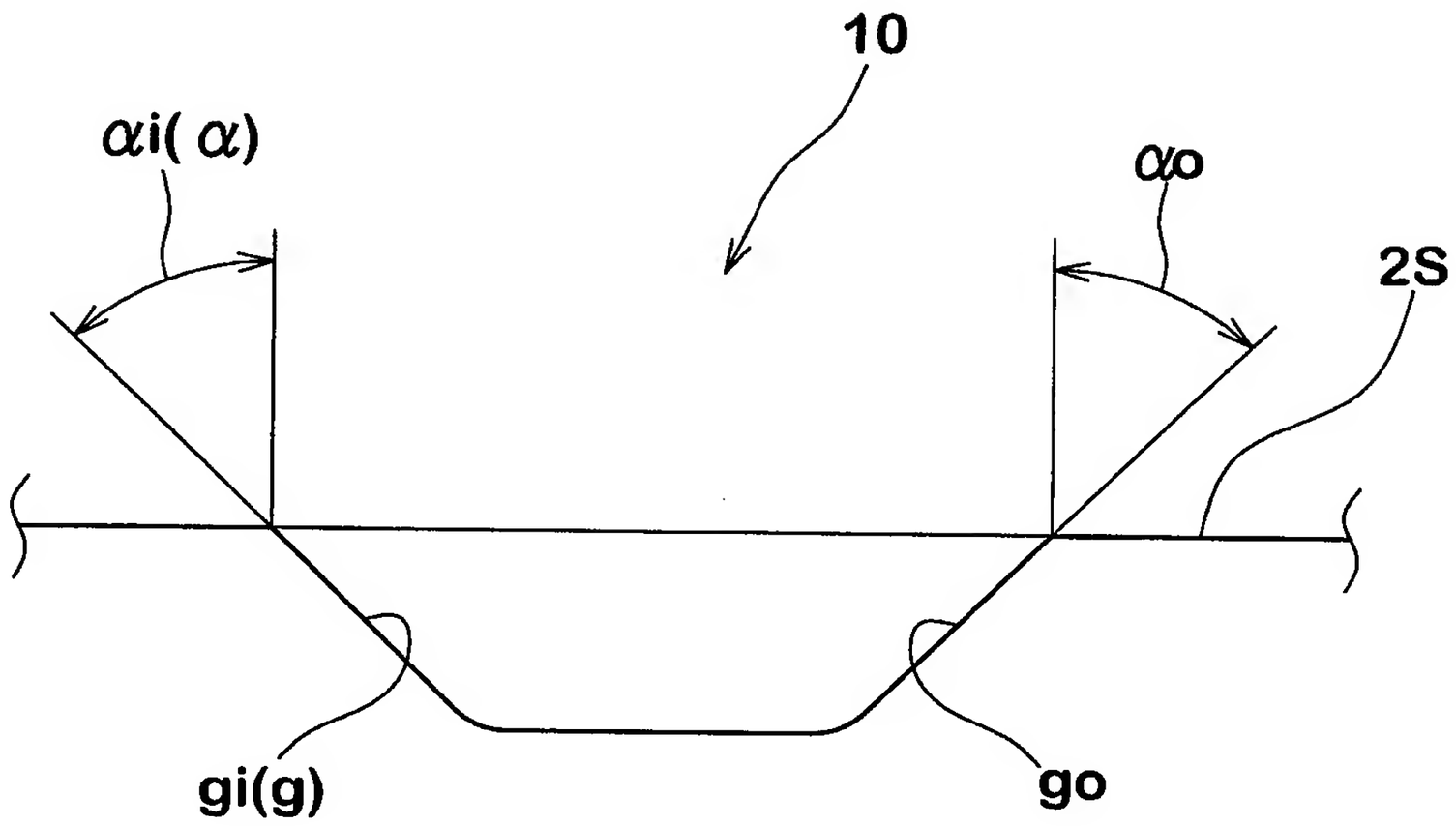


FIG.4(A)

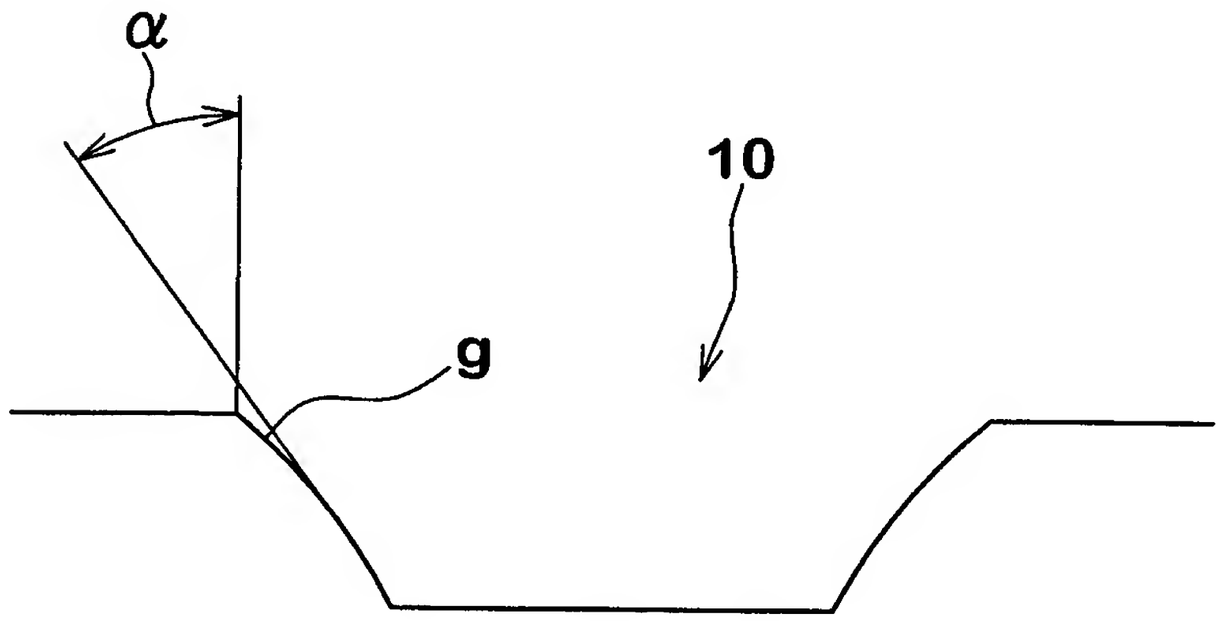


FIG.4(B)

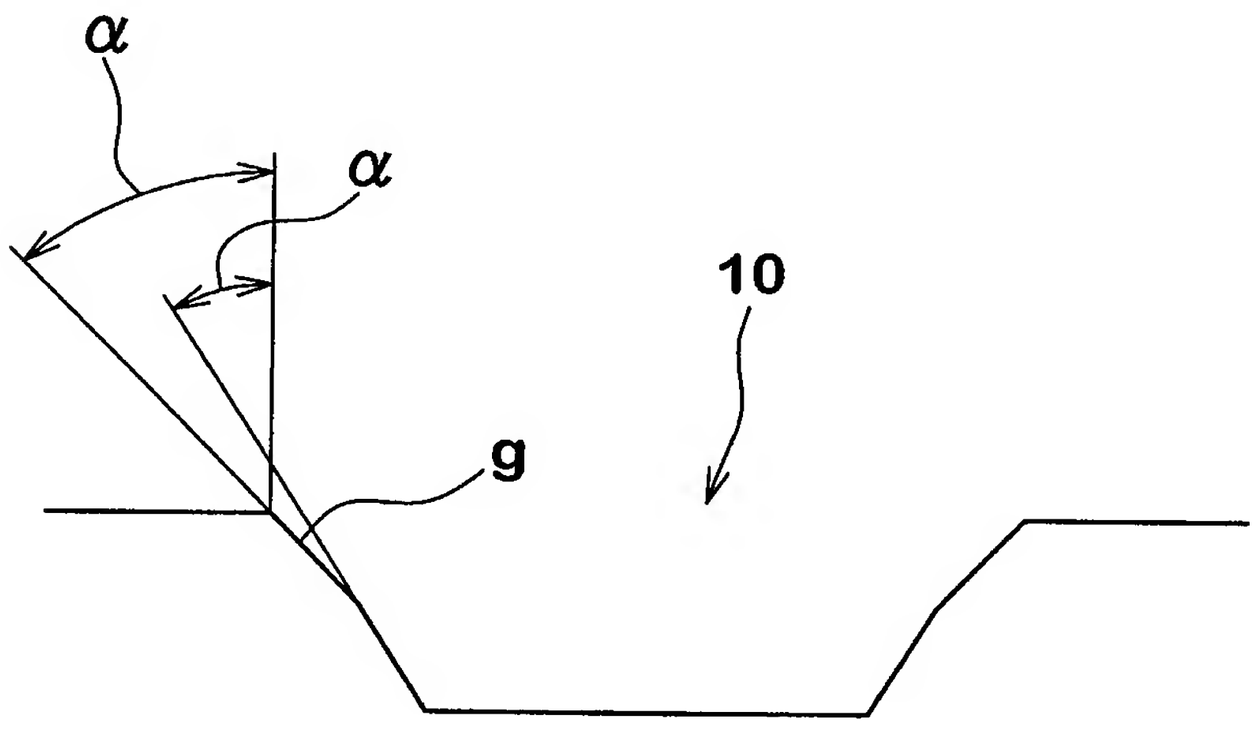


FIG.5

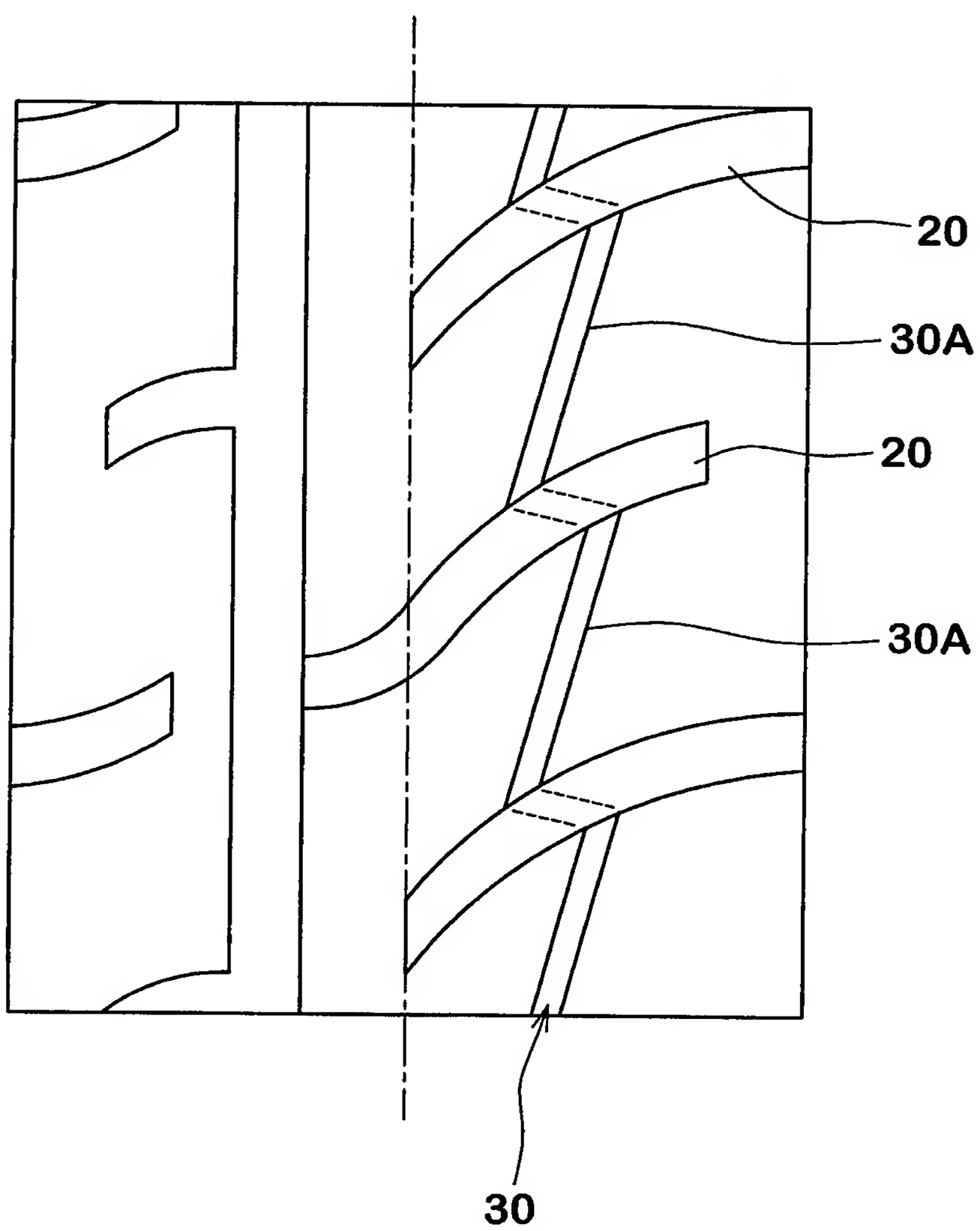


FIG.6

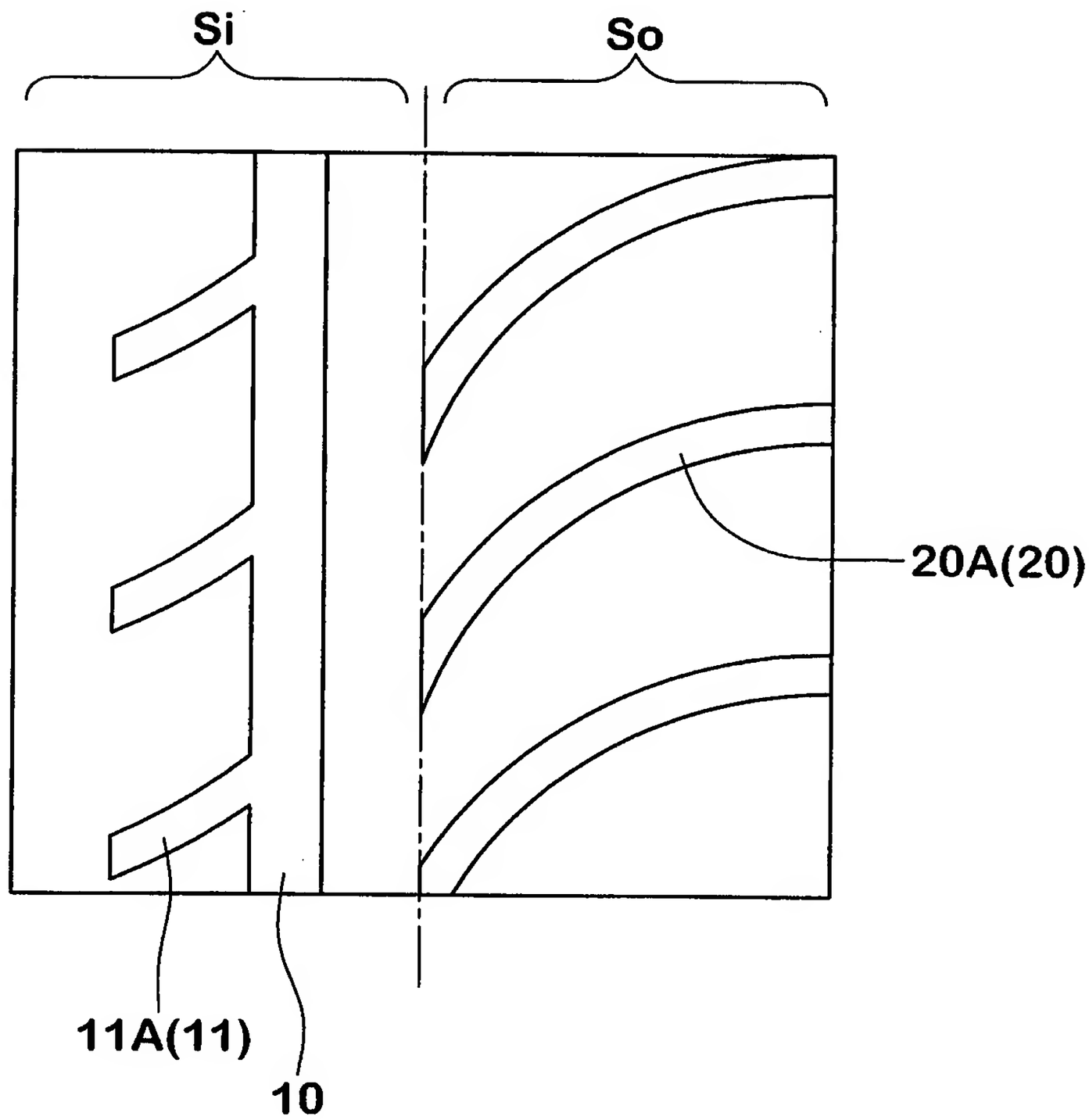


FIG.7(A)

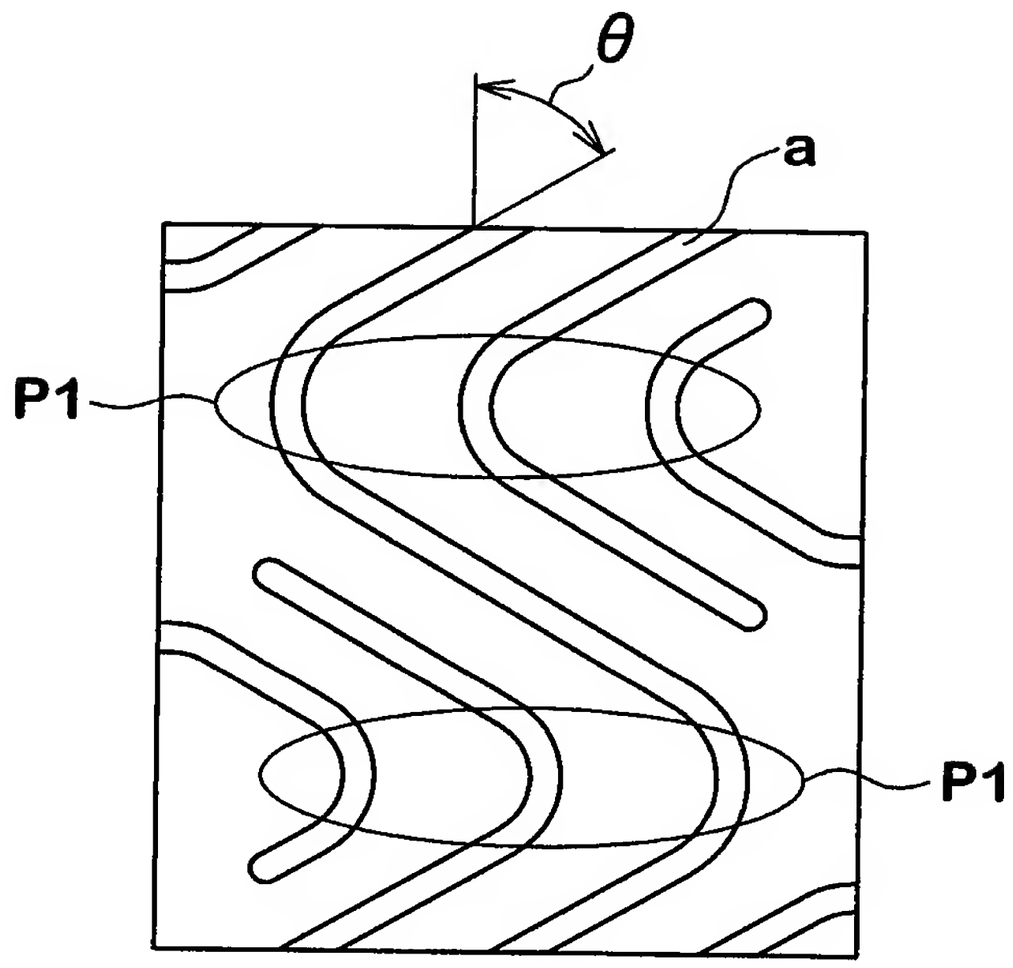
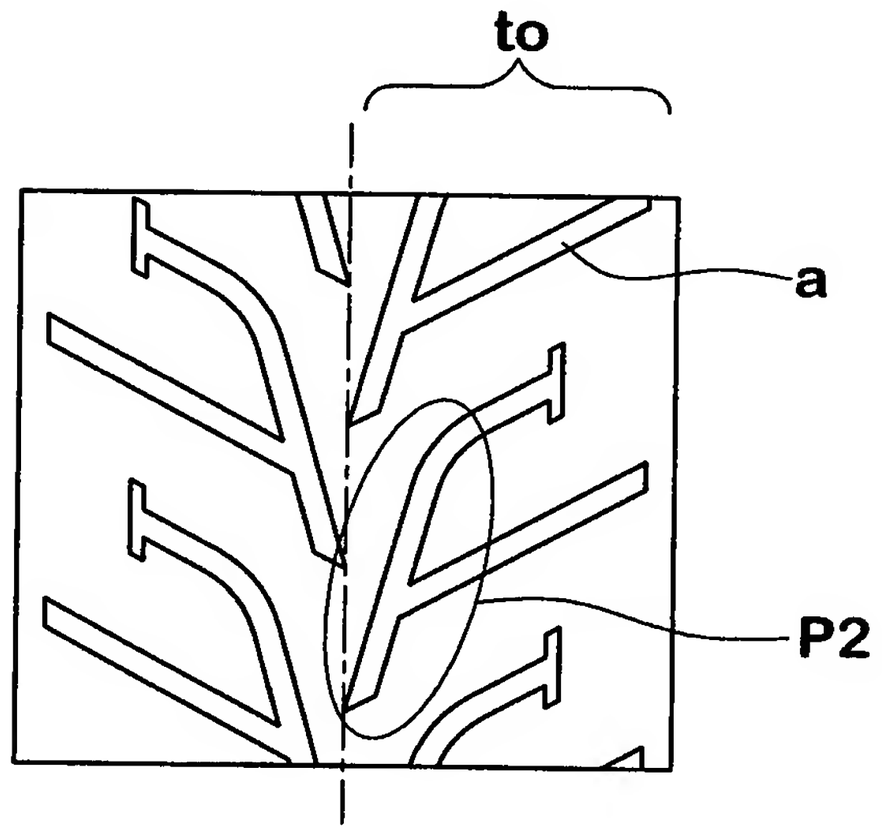


FIG.7(B)



PNEUMATIC TIRE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a pneumatic tire capable of exhibiting high dry grip performance and wear resistance when racing, such as for circuit racing and for gymkhana races while sufficiently securing excellent wet grip performance (hydroplaning resistance) when running on a general road.

Prior Art

For high performance tires produced not only for running on a general road but also for racing, such as for circuit racing and for gymkhana races, use is widely made of an S-shape pattern produced mainly for the sake of enhancing the dry grip performance as shown in Fig. 7(A) and of a V-shaped pattern produced mainly for the sake of enhancing both wet grip performance and dry grip performance as shown in Fig. 7(B) (see Figs. 2 and 8 of Japanese Patent Application Laid-open No. 2000-127715).

In the S-shaped pattern, since pattern rigidity with respect to the lateral acceleration (lateral G) is high, although the dry grip performance (especially lateral grip performance) is excellent, there is a tendency for wear to proceed quickly in a portion P1 where an angle θ between a tread groove a and a circumferential direction of the tire becomes small. The

majority of the tread groove has a large angle θ of 35° or more, and the hydroplaning resistance is inferior.

In the V-shaped pattern, the wet grip performance is excellent, but when a vehicle races on a road or surface having a high friction coefficient μ, such as a race course at high lateral acceleration (lateral G), the lateral rigidity in an outer tread half located at an outer side of the vehicle is not high, and it is difficult to shorten the running time or lap time even if composition of tread rubber and a structure of the tire are changed. There is a problem that in the tread groove disposed in the outer tread half, a portion P2 where the angle θ becomes 35° or smaller is worn fast.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a pneumatic tire capable of appropriately enhancing the pattern rigidity while securing an excellent dewatering effect, and capable of further enhancing dry grip performance, wet grip performance and wear resistance

To achieve the above object, claim 1 of the present application provides a pneumatic tire having an asymmetric pattern in which tread patterns on opposite sides of the tire with respect to a tire equator are different from each other, wherein

a tread surface is divided in a virtual manner from the

tire equator into an inner tread half located at an inner side of a vehicle when the tire is mounted to the vehicle and an outer tread half located at an outer side of the vehicle,

a groove area ratio Li of the tread pattern in the inner tread half is set greater than a groove area ratio Lo of the tread pattern in the outer tread half by 0.05 or greater ($Li-Lo \geq 0.05$), with a groove area ratio L of the tread pattern of the entire tread surface lying in a range of 0.15 to 0.35,

the inner tread half includes a straight circumferential main groove which continuously extends in a circumferential direction of the tire and which is disposed in a region Y away from the tire equator by a distance corresponding to 20 to 55% of a tread half width from the tire equator to the tread end,

an inclination angle α of the groove wall surface of the circumferential main groove with respect to a normal toward the tread surface is 30 to 50°,

the outer tread half is not provided with a circumferential groove which continuously extends in the circumferential direction of the tire, but is provided with an outwardly inclined lateral main groove having a lateral groove main portion which extends from an inner end on the tire equator toward the tread end and having an inclination angle β of 35° or greater formed between the lateral groove main portion and the circumferential direction of the tire, and

the outwardly inclined lateral main groove includes an

inner communication portion which is connected to an inner end of the lateral groove main portion and which is in communication with the circumferential main groove beyond the tire equator and/or an outer communication portion which is connected to an outer end of the lateral groove main portion and which is in communication with the tread end, the inclination angle β at the communication position of the communication portion being in the range from 75 to 90°.

A general summary of the tire of the present invention is given in claim 2.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of an embodiment of a pneumatic tire of the present invention;

Fig. 2 is a development of a tread pattern of the tire;

Fig. 3 is a lateral sectional view of a circumferential main groove;

Figs. 4(A) and (B) are diagrams for explaining an inclination angle of a groove wall surface of the circumferential main groove;

Fig. 5 is a diagram showing one example of a circumferential groove which is to be eliminated from an outer tread half;

Fig. 6 is a development showing another embodiment of a tread pattern used in the invention; and

Figs. 7(A) and (B) are developments showing one example

of a tread pattern of a conventional tire.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be explained with reference to the drawings. Fig. 1 shows a meridional cross section of a pneumatic tire according to the present invention. Fig. 2 shows a tread pattern of the pneumatic tire and the arrow shows the direction in which the tyre turns.

In Fig. 1, the pneumatic tire 1 is a high performance tire produced for both running on a general road and running on a race track such as for circuit racing and for gymkhanas. The pneumatic tire 1 includes a carcass 6 of a radial structure. The carcass 6 extends under the tread portion 2 and at both sides of the tire to respective bead cores 5 of bead portions 4 through respective sidewall portions 3.

A belt layer 7 is provided radially outward of the carcass 6 and radially inward of the tread portion 2. A tire aspect ratio H/W, which is a ratio of the height H of a tire cross section and the tire width W, is set to 50% or lower (e.g., 40%) by hoop effect. With this configuration, tire rigidity is enhanced, the tread width TW is increased, and high speed performance and steering stability are enhanced.

Here, the "tread width TW" is a distance of the tire in its axial direction between the lateral limits of the tread, i.e. the tread ends E_1 and E_o. Here, a point of intersection

of a phantom line which is obtained by extending an outline of the tread surface 2S outwardly in the axial direction of the tire and a phantom line obtained by extending an outline of a buttress surface 3S outwardly in a radial direction of the tire is defined as "J". The "tread end E" is a point where a line in the radial direction of the tire passing through this intersection point J intersects with the tire surface.

In the pneumatic tire 1 of this invention, when the tread surface 2S is divided in a virtual manner from a tire equator C into an inner tread half Si located at an inner side of a vehicle when the tire is mounted to the vehicle and an outer tread half So located at an outer side of the vehicle. A tread pattern of the inner tread half Si and a tread pattern of the outer tread half So are different from each other and are asymmetric with respect to each other.

More specifically, as shown in Fig. 2, the inner tread half Si includes one circumferential main groove 10 which extends continuously in a circumferential direction of the tire and thus forms a straight line in a flat development of the tread surface as shown in Fig. 2. In other words, the circumferential groove 10 lies in a plane parallel to an equatorial plane of the tire. The circumferential main groove 10 is formed in a region Y separated from the tire equator C by a distance corresponding to 20 to 55% of a tread half width TW/2 (1/2 of the tread width TW).

The circumferential main groove 10 is a straight groove having high dewatering effect, and its groove width GW0 is 14 mm or wider, and preferably 18 mm. It can e.g. be a maximum of about 25 mm wide. A center line of the groove is located in the region Y. That is, a distance L0 between the groove center line and the tire equator C is 20 to 55% of the tread half width TW/2.

If the circumferential main groove 10 is disposed further towards the outer side of the vehicle from the region Y, pattern rigidity in the outer tread half So can not sufficiently be secured, and it becomes difficult to satisfy the requirement for high dry grip performance and wear resistance at a high level which is required in the case of racing. If the circumferential main groove 10 is disposed further toward the inner side of the vehicle than the region Y, the wet grip performance required when running on a general road can not sufficiently be secured.

For securing the dry grip performance and wear resistance, in a groove cross section which is perpendicular to the groove center line of the circumferential main groove 10, as shown in Fig. 3, it is preferable that the groove wall surface g is inclined at an inclination angle α as great as 30 to 50° with respect to a normal of the groove side edge with respect to the tread surface 2S. A large lateral force is applied to the outer side of the vehicle as compared with the inner side of the vehicle especially when the vehicle turns. Therefore, it is preferable that an inclination angle αo of a groove wall surface go located

towards an outer side of the tire is greater ($\alpha o > \alpha i$) than an inclination angle αi of a groove wall surface gi located towards an inner side of the tire within the above-described angle range. If the inclination angle α is less than 30°, the rigidity in the vicinity of the groove side edge is insufficient, deviated wear such as orbit wear is caused and the wear resistance deteriorates. If the inclination angle α exceeds 50°, the groove volume is reduced and the dewatering effect deteriorates.

When the groove wall surface g is curved into a convex circular shape as shown in Fig. 4(A), an inclination angle α of a tangent at each position of the curved surface is in a range of 30 to 50°. When the groove wall surface g is a bent surface having a plurality of surfaces or facets as shown in Fig. 4(B), an inclination angle α of each surface or facet is in a range of 30 to 50°. When the inclination angle αi and the inclination angle αo are compared with each other, if the groove wall surface g is the curved surface, the comparison is made using an average value of a maximum value and a minimum value of the inclination angle α of the tangent, and if the groove wall surface g is the bent surface, the comparison is made using an average value of the inclination angles α of the surfaces.

The inner tread half Si can be provided with an inner inclined lateral main groove 11 between the circumferential main groove 10 and the inner tread end Ei. The inner inclined lateral main groove 11 of this example includes a first inner inclined

lateral main groove 11A whose inner end is in communication with the circumferential main groove 10 and whose outer end is spaced from the inner tread end Ei by a distance L1 in the axial direction of the tire.

Especially in this example, the inner inclined lateral main groove 11 includes, in addition to the first inner inclined lateral main groove 11A, a second inner inclined lateral main groove 11B whose outer end is in communication with the inner tread end Ei and inner end is away from the circumferential main groove 10 by a distance L2 in the axial direction of the tire. It is preferable that the first and second inner inclined lateral main grooves 11A and 11B are disposed alternately in the circumferential direction in terms of uniformity.

The distances L1 and L2 are preferably 7% to 14% of the tread width TW. If the distances are less than 7%, the rigidity is lowered and there is a tendency for the dry grip performance and the wear resistance to deteriorate. If the distances exceed 14%, there is a tendency for the wet grip performance to reduce. To secure the wet grip performance, it is preferable that the first and second inner inclined lateral main grooves 11A and 11B are superposed on each other in the circumferential direction of the tire to form a superposed or overlapping portion 12 (overlap in the axial direction).

It is preferable that the inclination angle γ formed between the inner inclined lateral main groove 11 and the circumferential

direction is 35° or greater. It is especially preferable that an inclination angle γ1 formed between the circumferential main groove 10 and the inner groove end at their communication position is 75 to 90°. With this configuration, it is possible to suppress the excessive reduction in rigidity and deterioration of wear resistance at the communication position.

Since greater lateral force is applied to the outer tread half So when the vehicle turns, higher lateral rigidity is required. For this purpose, as shown in Fig. 2, the outer tread half So is not provided with a circumferential groove continuously extending in the circumferential direction of the tire, and is formed with an outwardly inclined lateral main groove 20 inclined with respect to the circumferential direction of the tire.

The above expression that "the outer tread half So is not provided with a circumferential groove continuously extending in the circumferential direction of the tire" means that all circumferential grooves which may reduce the pattern lateral rigidity are eliminated. For example, grooves which should be eliminated are a main groove having a width of 3 mm or wider provided mainly for the sake of dewatering, a thin groove having a width of 1.0 to 3 mm provided mainly for the sake of optimizing the dewatering and pattern rigidity, and a siping having a width of less than 1.0 mm provided mainly for the sake of optimizing the patter rigidity and securing the edge effect. As briefly

shown in Fig. 5, connection grooves 30A which sequentially connect the outwardly inclined lateral main grooves 20 and 20 to each other and which are adjacent to each other in the circumferential direction of the tire can also be regarded as one zigzag circumferential groove 30, and such grooves should also be eliminated.

The outwardly inclined lateral main groove 20 (Fig. 5) includes at least a lateral groove main portion 21 (Fig. 2) which has an inclination angle β of 35° or greater with respect to the circumferential direction of the tire and which extends from an inner end 21Ei on the tire equator C toward an outer tread end Eo. For alternate lateral grooves 20B the lateral groove main portions 21 are continuously provided with an inner communication portion 22i which extends from a position corresponding to the inner end 21Ei to the circumferential main groove 10 and which is in communication with the circumferential main groove 10 beyond the tire equator C. Every second lateral groove 20A has a main portion 21 which starts at a position corresponding to 21Ei and has an outer communication portion 22o which extends to an outer end 21Eo of the lateral groove main portion 21 and which is in communication with the outer tread end Eo.

Thus, in this example, the outwardly inclined lateral main groove 20 includes first outwardly inclined lateral main grooves 20A whose outer communication portions 22o are connected to the

lateral groove main portions 21, and second outwardly inclined lateral main grooves 20B whose inner communication portions 22i are connected to the lateral groove main portions 21. It is preferable that the first and second outwardly inclined lateral main grooves 20A and 20B are alternately disposed in terms of uniformity. If necessary, an edge-projecting portion 24 (shown with a chain-dotted line in Fig. 2) can extend from the inner end 21Ei of the lateral groove main portion 21 of groove 20A beyond the tire equator C and can be separated from the circumferential main groove 10 by a distance L3 in the axial direction of the tire. Such an extension 24 can be provided as part of the first outwardly inclined lateral main groove 20A.

Here, in the outwardly inclined lateral main groove 20, it is necessary that the inclination angle β is 35° or greater. If the angle is less than 35°, the lateral rigidity of the pattern with respect to the lateral force at the time of turning of the vehicle is insufficient. As a result, the dry grip performance (especially lateral grip performance) during racing becomes insufficient, running time can not be enhanced, and the wear resistance in the vicinity of the groove side edge of the outwardly inclined lateral main groove 20 deteriorates.

There is a tendency that in the outwardly inclined lateral main groove 20, the rigidity of the communication position between the outer tread end Eo and the circumferential main groove 10 is reduced, and that the wear resistance deteriorates. Thus,

it is important that the inclination angle β1 at the communication position of the communication portions 22i and 22o is set in a range of 75 to 90° and the reduction in rigidity is suppressed.

When the outwardly inclined lateral main grooves 11 and 20 are curved, the inclination angles β and γ are indicated by the inclination angle of the local tangent to the main grooves.

In the second outwardly inclined lateral main groove 20B, it is preferable that a distance L4 between its outer end and outer tread end Eo is 10 to 20% of the tread width TW. If the distance L4 is less than 10%, the rigidity is reduced and there is a tendency for the dry grip performance and the wear resistance to reduce. If the distance L4 exceeds 20% on the contrary, there is a tendency to reduce the wet grip performance. If the first outwardly inclined lateral main groove 20A is provided with the edge-projecting portion 24, it is preferable that the distance L3 between the edge-projecting portion 24 and the circumferential main groove 10 is 12% or more of the tread width TW in order to secure the dry grip performance and wear resistance.

Next, in the pneumatic tire 1 of the present invention, a groove area ratio L of the tread pattern in the entire tread surface 2S is in a range of 0.15 to 0.35. A groove area ratio Lo of the tread pattern in the outer tread half So is set smaller than a groove area ratio Li of the tread pattern in the inner tread half Si by 0.05 or smaller ($Li-Lo \geq 0.05$) so that the pattern rigidity is enhanced and greater lateral grip can be obtained

in the outer tread half So. The groove area ratio means a ratio of an opening area of the tread groove which occupies the tread surface to the total area of the tread surface.

If the groove area ratio L is less than 0.15, it is difficult to secure the necessary wet grip performance. If the groove area ratio L is greater than 0.35 and if a difference Li-Lo of the groove area ratios is less than 0.05, it becomes difficult to satisfy the high dry grip performance and wear resistance required for racing. It is preferable that the difference Li-Lo of the groove area ratios is 0.12 or less in terms of the wet grip performance.

The inner and outwardly inclined lateral main grooves 11 and 20 are dewatering main grooves having widths GW1 and GW2 of 3 mm or more. The upper limit values of the groove widths GW0, GW1 and GW", and forming pitches of the inner and outwardly inclined lateral main grooves 11 and 20 are appropriately set in accordance with the groove area ratio L, and the difference Li-Lo of the groove area ratios.

Next, with reference to Fig. 1, in order to largely enhance the turning performance while sufficiently utilizing the excellent lateral grip performance, a ratio Hi-Ho of a radial distance Hi of the inner tread end Ei from the tire equator point CO and a radial distance Ho of the outer tread end Eo from the tire equator point CO is 1.02 to 1.20, and the pneumatic tire 1 of the present invention has an asymmetric tread outline shape.

When a vehicle turns, in a tire thereof closer to the turning center, a ground-contact center of the tire is on the side of the inner tread half Si. In a tire of the vehicle on the opposite side from the former tire closer to the turning center, a ground-contact center of the tire is on the side of the outer tread half So. At that time, if the ratio Hi/Ho is 1.02 to 1.20, an actual rotating radius of the tire closer to the turning center, i.e., an actual rotating radius on the side of the inner tread half Si can be smaller than an actual rotating radius of the tire opposite from the turning center, i.e., an actual rotating radius of the outer tread half So, and the vehicle can turn smoothly. If the ratio Hi/Ho is less than 1.02, the above effect can not be exhibited, and if the ratio exceeds 1.20, there are tendencies for the straight running performance to deteriorate, for the ground-contact pressure distribution to become uneven, and for the wear resistance to deteriorate.

Fig. 6 shows another embodiment of the tread pattern. In Fig. 6, an inner inclined lateral main groove 11 comprising only the first inner inclined lateral main groove 11A is disposed in the inner tread half Si, and an outwardly inclined lateral main groove 20 comprising only the first outwardly inclined lateral main groove 20A is disposed in the outer tread half So.

Although the preferred embodiment has been described in detail, the tire of the present invention can be employed as a tire for a general passenger car, and the invention is not

limited to the illustrated embodiment, and the invention can be variously modified and carried out.

Examples

Pneumatic tires (255/40ZR17) having the structure shown in Fig. 1 and having tread patterns shown in Figs. 2, 6 and 7 were prototyped in accordance with specifications shown in Table 1, the wet grip performance and running time in a gymkhana race of the prototyped tires were measured, and results thereof are shown in Table 1. Specifications not shown in Table 1 are substantially the same.

(1) Wet grip performance (straight hydroplaning resistance):

The prototyped tires were mounted to all wheels of a passenger car (2600 cc) having rims (9J×17) and internal pressure (230 kPa), the vehicle was allowed to accelerate on a straight road (depth of water was 10 mm), and the acceleration limit speed was measured. Results of the measurement are shown with indices in which a comparative example 1 is 100. The higher the numeric value, the more excellent the result is.

(2) Wet grip performance (lateral hydroplaning resistance):

The same vehicle was allowed to run on an asphalt road surface having a puddle (depth of water was 5 mm and length was 20 m), the speed was increased in stages, the lateral acceleration

(lateral G) was measured, and average lateral G of a front wheel at the speed of 50 to 80 km/h was calculated. The average lateral G is indicated with indices in which the comparative example 1 is 100. The higher the numeric value, the more excellent the result is.

Table 1

	Comparative Example 1	Example 1	Example 2
Tread pattern	Fig. 7	Fig. 6	Fig. 2
Groove area ratio L	0.22	0.22	0.22
Groove area ratio Li	0.22	0.24	0.26
Groove area ratio Lo	0.22	0.20	0.18
Circumferential main groove	No groove	Straight	Straight
Groove width GW0 (mm)	–	18	18
Distance L0 (mm)	–	45	45
Inclination angle of groove wall surface (°) (αi, αo)	–	(45, 45)	(45, 45)
Inner inclined lateral main groove	No groove	Groove	Groove
Groove width GW1 (mm)	–	14	14
Inclination angle γ (minimum value) (°)	–	55	65
Inclination angle γ1 (°)	–	55	90
Distance L1 (mm)	–	34	34
Distance L2 (mm)	–	–	19
Outer inclined lateral main groove	No groove	Groove	Groove
Groove width GW2 (mm)	–	13	13
Inclination angle β (minimum value) (°)	–	50	50
Inclination angle β1 (°)	–	90	90
Distance L3 (mm)	–	36	36
Distance L4 (mm)	–	–	36
Straight hydroplaning resistance	100	102	105
Lateral hydroplaning resistance	100	103	105
Running time	1′01″42	1′01″05	1′00″84

It is thus confirmed that, for the present examples of the tire of the invention (Examples 1 and 2), both the wet grip performance and dry grip performance is enhanced.

Effect of the Invention

Since the present invention has the above-described structure, it is possible to appropriately enhance the pattern rigidity while securing excellent dewatering effect, and the dry grip performance, hydroplaning resistance, and wear resistance can be enhanced.

WHAT IS CLAIMED IS:

1. A pneumatic tire having an asymmetric pattern in which tread patterns on opposite sides of the tire with respect to a tire equator are different from each other, wherein

a tread surface is divided in a virtual manner from the tire equator into an inner tread half located at an inner side of a vehicle when the tire is mounted to the vehicle and an outer tread half located at an outer side of the vehicle,

a groove area ratio Li of the tread pattern in the inner tread half is set greater than a groove area ratio Lo of the tread pattern in the outer tread half by 0.05 or greater (Li-Lo $\geq$ 0.05), and a groove area ratio L of the tread pattern of the entire tread surface is in a range of 0.15 to 0.35,

the inner tread half includes a straight circumferential main groove which continuously extends in a circumferential direction of the tire and which is disposed in a region Y away from the tire equator by a distance corresponding to 20 to 55% of a tread half width from the tire equator to the tread end, an inclination angle α of the groove wall surface of the circumferential main groove with respect to a normal toward the tread surface is 30 to 50°,

the outer tread half is not provided with a circumferential groove which continuously extends in the circumferential direction of the tire, but is provided with an outwardly inclined

lateral main groove having a lateral groove main portion which extends from an inner end on the tire equator toward the tread end and having an inclination angle β of 35° or greater formed between the lateral groove main portion and the circumferential direction of the tire, and

the outwardly inclined lateral main groove includes an inner communication portion which is connected to an inner end of the lateral groove main portion and which is in communication with the circumferential main groove beyond the tire equator and/or an outer communication portion which is connected to an outer end of the lateral groove main portion and which is in communication with the tread end, the inclination angle β at the communication position of the communication portion being 75 to 90°.

2. A pneumatic tire having a tread extending from an outer tire shoulder across an equatorial plane of the tire to an inner tire shoulder, said tread having a first pattern between said inner tire shoulder and said equatorial plane and a second pattern between said equatorial plane and said outer tire shoulder, said first pattern including a substantially straight circumferential main groove spaced from said equatorial plane and said inner tire shoulder, said second pattern not having a circumferential groove but a plurality of laterally extending main grooves, each having a main portion extending generally

between said equatorial plane and a position spaced inwardly of said outer tire shoulder and inclined at an angle β above 35° to a local circumferential direction of the tire, at least some of said main portions being extended by further main groove sections communicating with said circumferential groove and/or being extended by other main groove sections to said outer tire shoulder and being axially outwardly open there.

3. The pneumatic tire according to claim 1 or claim 2, wherein the outwardly inclined lateral main groove comprises only a first outwardly inclined lateral main groove in which an outer communication portion is connected to the lateral groove main portion.

4. The pneumatic tire according to claim 1 or claim 2, wherein the outwardly inclined lateral main groove includes a first outwardly inclined lateral main groove in which an outer communication portion is connected to the lateral groove main portion, and a second outwardly inclined lateral main groove in which an inner communication portion is connected to the lateral groove main portion.

5. The pneumatic tire according to claim 4, wherein the outwardly inclined lateral main groove comprises alternately disposed first outwardly inclined lateral main grooves and second

outwardly inclined lateral main grooves.

6. The pneumatic tire according to any one of claims 1 to 5, wherein in the tread surface, a ratio Hi/Ho of a radial distance Hi from a tread end of the inner tread half to the tire equator and a radial distance Ho from a tread end of the outer tread half to the tire equator is 1.02 to 1.20.

7. A tire in accordance with claim 2, wherein said main circumferential groove has groove wall surfaces inclined at an angle α within the range 30° to 50° with respect to a normal to the tire surface.

8. A tire in accordance with any one of the preceding claims, wherein said main circumferential groove has a width in the range from 14 mm to 25 mm.

9. A tire in accordance with any one of the preceding claims, wherein said first tread pattern includes first inner laterally extending grooves communicating with said main circumferential groove and second outer laterally extending grooves extending from said inner tire shoulder in the direction towards said equatorial plane.

10. A tire in accordance with claim 9, wherein said inner

laterally extending grooves and said outer laterally extending grooves are inclined to the tread running direction, i.e. to a circumferential direction of the tire, by an angle less than 90° over at least a major portion of their lengths.

11. A tire in accordance with claim 2, wherein a groove area ratio Li of the tread pattern in the inner tread half is set greater than a groove area ratio Lo of the tread pattern in the outer tread half by 0.05 or greater ($Li-Lo \geq 0.05$), and a groove area ratio L of the tread pattern of the entire tread surface is in a range of 0.15 to 0.35.

12. A tire in accordance with claim 2, wherein said main circumferential groove is disposed in a region spaced from said equatorial plane by a distance lying in the range of 20-55 % of a width corresponding to the distance between said inner tire shoulder and said equatorial plane.

13. A pneumatic tire substantially as described herein with reference to and as illustrated in the accompanying drawings of Figs. 1 to 6.

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Application No: GB0410555.7 **Examiner:** Roger Binding

Claims searched: 1-13 **Date of search:** 19 July 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular reference
X,P	2, 4, 5, 9-12	EP 1314581 A (SUMITOMO RUBBER), see especially Fig 2 and paras. 0020-0028.
X,P	2, 4, 5, 9, 10	JP 2003200711 A (SUMITOMO RUBBER), see abstracts and drawings.
X	2, 4, 5, 9, 10, 12	JP 11198608 A (OHTSU TIRE & RUBBER), see abstracts and drawings.
A	-	GB 1310192 A (DUNLOP)
A	-	JP 08164714 A (YOKOHAMA RUBBER), see abstracts and drawings.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W] :

B7C

Worldwide search of patent documents classified in the following areas of the IPC[07]

B60C

The following online and other databases have been used in the preparation of this search report

Online WPI EPODOC JAPIO

24